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# THE AIRCRAFT PRODUCTION BOARD[1]

THE Aircraft Production Board was authorized by resolution of the Council of National Defense on May 16. 1917. By this resolution it was authorized:

1. To co-operate with the plane and engine design department of the army and navy, and with manufacturers and engineering laboratories to advance the science of aviation, and to stimulate the production of a better type of aircraft.
2. To advise and assist in standardization of material and parts.
3. To investigate the source of supply of aircraft and the materials entering into them, with a view to co-ordination of designs of all aircraft matters through the officers of the allied countries stationed here; arrangements with existing American factories as to kinds of aircraft best suited to their organizations and facilities; suitable arrangements when necessary to advance government funds or to make arrangements on a cost-plus basis; and utilization of idle facilities and creation of new sources of supply as in the judgment of the board may be necessary.
4. To co-operate with the inspection organizations of the army and navy.
5. Following the selection of sites for aviation schools and supply sites, by the military departments, to advise in regard to buying or leasing the land, preparing it for use, and erecting all buildings.
6. To advise regarding priority of deliveries of aircraft material as between the departments.

It will be noticed that the word "advise" is repeatedly used in this authorization. The board has never assumed to act in any other capacity, and has confined its work to the non-military and industrial phases of the situation.

On October 1, 1917, Congress passed an act making the Aircraft Production Board a body separate from the Council of

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[1] Read by title at the meeting of the Academy of Political Science, December 14, 1917. This article is reprinted by permission from the First Annual Report of the Council of National Defense. The personnel of The Aircraft Board has been brought down to date.

National Defense, and changing its name to The Aircraft Board, with power "to supervise and direct, in accordance with the requirements prescribed or approved by the respective departments, the purchase, production and manufacture of aircraft, engines and all ordnance and instruments used in connection therewith."

The membership of the Aircraft Board on January 1, 1918, was as follows: Howard E. Coffin, Chairman; Brig. Gen. Geo. E. Squier, Chief Signal Officer, U. S. A.; Rear Admiral David W. Taylor, Chief Constructor of the Navy; Col. E. A. Deeds, of the Administration Division of the Signal Corps; Col. R. L. Montgomery, head of the Equipment Division of the Signal Corps; Capt. N. E. Irwin, Chief of the Bureau of Naval Operations, U. S. N.; Lieut. Commander A. K. Atkins, Chief of the Bureau of Steam Engineering, U. S. N.; and R. F. Howe, who is Vice-Chairman of the Board and its second civilian member. A third civilian member, provided for in the act, is still to be appointed by the President.

One of the desirable features of the board is that it represents a co-ordination of both army and navy effort in the production of aircraft. Although the navy's undertaking in aircraft work promised to be smaller than that of the other branch of the service, the board has devoted much of its thought to the proper handling of the naval program and at the request of the secretary of the navy has reserved several plant units exclusively for navy work.

It was evident at the outset that the problem which lay before the board was to create an industry where none had existed before. The members of the board at once realized that close study should be given to conditions in the airplane industry with a view to considering possibilities of production as they existed at the time. The history of the industry in this country, while full of brilliant accomplishments in many ways, had been on the whole admittedly a slender one from the standpoint of successful manufacturing enterprises. The only considerable market for the products of the industry was the government, and with small appropriations for this work and a very proper desire on the part of the government to encourage all the different factories, the business was piecemeal, and no opportunity was possible for putting production on anything like a commercial basis, as it is known in other businesses. No evidence was obtainable that any appreciable amount of profit had been made, and there was plenty of evidence that a great deal of money had been lost in too venturesome undertakings.

The basis for the entire program of production was a report made to the secretary of war and the secretary of the navy by the joint army and navy technical board on design and specifications. This board, composed of three officers from each service, skilled in matters of aircraft and answerable directly to the two secretaries, represents one of the increasing number of instances of co-ordination between the two services which are so desirable.

The schedule decided on and incorporated in the board's report was determined with careful consideration of allied experience and needs in relation to those of the United States.

The cause of aviation was urged strongly by members of the missions that visited this country in the early summer, and great pressure was brought to bear to turn as much of our resources into this channel as possible. There was at the same time a frank uncertainty about our being able to accomplish any considerable part of what had been outlined.

The magnitude of the program was at once appreciated and the approval of the War College division of the General Staff was immediately sought.

On June 15, 1917, the War College division addressed a memorandum to Howard E. Coffin, chairman of the Aircraft Production Board:

1. Inquiring as to the extent to which the board's proposed production of airplanes and engines would interfere with the production of (*a*) artillery material, (*b*) machine guns, (*c*) motor trucks, as planned by other departments of the government.
2. Whether the personnel required for the production of airplanes could be obtained without interference with the production of the above-mentioned war material.
3. Asking that the board obtain a statement of clearance from the General Munitions Board and the Priorities Board of the Council of National Defense with respect to both such personnel and material.

This matter was immediately taken up by the Aircraft Production Board, and on June 16 the chairman received a letter from the General Munitions Board, stating that the aircraft program would not interfere with the forging or machine capacity of the country or the motor-truck program.

It was further suggested by the General Munitions Board, with reference to the production of machine guns, that additional facilities would have to be provided for the requirements of the aviation program, and that the matter should be considered by the machine-gun committee of the General Munitions Board. The latter further stated that there would be no interference in the matter of personnel with the operations of other industries essential to the war.

It was necessary to consider at once both the personnel involved in handling what promised to be such a large arm of the service, and also the funds necessary for its accomplishment. On June 30 a bill was under preparation by the airplane division of the Signal Corps, assisted by various members of the board, providing for an adequate service and calling for an appropriation of $640,000,000 for the twelve months ending June 30, 1918. The various members of the board were called upon to appear before the military committees of both House and Senate; the foreign officers attached to General Squier's staff also submitted evidence, and every effort was being made by members of both houses of Congress to give ungrudging support in launching the undertaking.

Considering for the present merely the problems of production, the work of the board resolved itself into two main divisions: (1) equipment for training purposes in this country, and (2) equipment for combat work at the front in France.

First consideration was given to the problem of securing training plans for the elementary training in this country of the pilots provided for by the joint technical board. It was found that a very satisfactory training plane and motor had been developed by an American company, which machine had been used in quantity by both England and Canada, and through the instrumentality of the board this training machine was adopted as the standard training machine for the three services. The fact developed, however, that while it was possible to secure the desired number of planes of this make from other plants, it would not be possible to secure enough motors of the type designed to fit this plane. The board was accordingly obliged to arrange for an additional type of training machine, which it did reluctantly, as the fundamental policy which it has adhered to wherever possible is the elimination of as many extra types as possible and the concentration on the fewest possible number of types of planes and engines.

When consideration was given to the program of combat, reconnaissance, and bombing planes, the major difficulties were encountered. Although America had been the first to develop the art of aviation, and much of the conspicuous work in the development of that art had been carried on in this country, almost three years of warfare in Europe under the stress of fierce military pressure had produced a development so rapid that the designs and ideas of motors and planes constructed in this country were of comparatively little use, and it was seen at once that so far as plane design was concerned we must rely to a large extent for the present on designs developed in the allied countries.

The same can be said of the motor situation, with this difference: Whereas the construction of the airplane itself and the translation of designs and specifications of these types from France and England presented comparatively fewer manufacturing difficulties for shops in the country, the attempts to produce foreign motors and translate them into the methods of our shop practice presented almost insurmountable difficulties. This fact is not at once understood until it is realized that the whole method of shop practice in the factories of France and Italy is different from that employed in the United States, and it has been the experience almost without exception that the attempt to manufacture in the United States a fine, delicately adjusted product on the plans and specifications used abroad has been almost invariably unsatisfactory. It is substantially a question of shop practice, rather than the individual skill of the workers, there being little doubt that many of the factories in this country today are competent to do machine work the equal of any to be found.

Fully aware of the difficulties involved, the board felt called upon to bring to this country at once as complete data as possible of many of the best types of English and French engines. The experience encountered with the designs for one of the finest French engines well exhibits the task. When the complete blue prints, including the material specifications, were received in this country, it was found impossible to put these engines into production in a plant here equipped to do the finest type of work because in the hurry and confusion of work under war conditions it appeared that the plans were not complete and the factory could not guarantee satisfactory results.

The board was soon in communication with so many brokers representing various factories in France and England whose products were being offered to the government for manufacture in this country, with large royalty considerations, that the policy was established of refusing to deal with any individual factory or their brokers. From then on it was decided that negotiations would be conducted exclusively between the United States government and the French, English or Italian governments. The Allied governments acquiesced willingly in this method of procedure and in certain ways it tended to strengthen their position with their own factories. The board took the position regarding the royalty matter that there should be free interchange of rights between governments of all matters pertaining to aircraft at this time, and that the advantage to the Allied cause of being able to convert the enormous industrial resources of the United States into the production of aircraft might fairly offset such patent rights as might accrue to individual factories abroad.

As indicated before, one of the immediate and in many ways most difficult problems to be faced from the standpoint of production was the lack of facilities in the industry from which could be expected any adequate results on a program as large as had been decided upon. To undertake an expenditure in excess of $400,000,000 within twelve months' time in an industry with a total investment of perhaps $10,000,000 meant that new facilities must be procured at once. Contrary to general opinion, all types of woodworking or machine-shop facilities are not readily adaptable to the manufacture of airplanes and airplane engines, and the board immediately realized that great care must be exercised in encouraging only such establishments to enter this new and rapidly changing business as were equipped from the standpoint of organization and capacity to be of real benefit. As was the case in all the foreign countries, the board looked to the automobile industry, with its vast organizations, for assistance in the production of motors, but for the plane production the task was not so easy.

As a broad general policy it was felt wise to avoid, as far as possible, the scattering of orders for planes and spare parts of planes among a great number of small shops.

The inspection difficulties involved where a great number of shops are working on jobs of this kind are so enormous and results generally so unsatisfactory that, wherever possible, efforts were made to encourage established institutions accustomed to handle things on a broad scale rather than encourage the conversion of small woodworking establishments of various kinds all over the country. Consideration had to be given to geographical location, as it was obviously unwise to encourage a greater production in any section of the country than could be used at the flying fields to be established there.

Great pains were taken in ascertaining the desirability of manufacturing plants for this work, and when an offer of a manufacturing plant was received an inventory was at once obtained from that plant, supplementing in even greater detail the inventory already on file with the industrial inventory section of the Council of National Defense. Financial statements, personnel of organization etc., were all noted, and if the prospect appeared good an industrial engineer was at once sent to the plant to make an exhaustive report of the production possibilities from the standpoint of aircraft.

Soon after it became apparent that America was prepared to take an aggressive part in the war in the air the problem of policy was presented to the board in varying ways—whether the manufacturing should be done entirely in this country and planes and engines shipped abroad complete or whether parts should be made in rough in this country and shipped abroad for finish and mounting in France, or finished parts shipped abroad for assembling in either French factories or large American assembling plants in France. Experiments were made by the board with shipments of planes in unassembled form, and serious consideration was given to this method.

The difficulties referred to in providing for production in this country of foreign motors made it imperative that something be done toward producing a motor here which, while fulfilling the requirements of service at the front, should at the same time be designed for quantity production in this country. Two courses were open—one to encourage our manufacturers to develop their own types; the other to bring the best of all types together and develop a standard motor.

The necessity for speed and quantity of production resulted in a choice of the latter course, and the designing of a standard motor became the board's engineering objective. Two of the best engineers in the country, both experts in aviation-motor design, were brought together at Washington and the problem of producing an all-American engine at the earliest possible moment was presented to them. Their first conference was held on June 3, and in consultation with engineers and draftsmen from the various sections of the country they worked continuously, and on June 30, which was twenty-four days after the drawings were started, the new engine, known as the "Liberty motor," was practically completed.

In connection with this work consulting engineers and motor manufacturers gave up their trade secrets as a patriotic measure under the emergency of war needs, and these latter industries also contributed the services of approximately 200 of their best draftsmen. The new engine embodied the best thought of engineering experience, and contributions to the final result came not only through celebrated consulting engineers of this country, but the representatives in the United States of England, France and Italy co-operated in its development.

It was so designed that all parts of the motor were standardized and might be produced rapidly and economically by many factories operating under government contracts. In short, the engine amounted practically to an international model, embodying the best thought of American engineering and foreign experience, so far as the latter could be adapted to American manufacturing methods.

A glance at the problems involved in negotiating with the Allied countries showed the imperativeness of immediate representation by the board over sea, and accordingly a commission, under the authority of the United States Signal Corps, was dispatched on June 17 to represent the United States in negotiations with the foreign air authorities, and to learn at first hand of the latest developments in plane and engine manufacture abroad. With this commission was sent a group of 103 mechanics, chosen from the best automobile factories in the United States. These men were assigned to a half dozen of the leading French factories to learn from the bench the intricacies and minute details of the manufacture of the most conspicuously successful motors. The work of this foreign mission was only beginning by July 1, and the comprehensive results of their efforts can consequently not yet be reported.

In considering the materials used in the manufacture of airplanes, the board discovered at once that the two major difficulties likely to be encountered were in the procurement of spruce and linen. Because of its lightness and at the same time great strength spruce has been almost exclusively used in the past in the manufacture of the struts, beams etc., of the airplanes. Propellers are made of different woods, chiefly mahogany and black walnut, and while it was not easy to secure adequate importations of mahogany, due to lack of bottoms, the situation was clearly well in hand as long as black walnut, and even birch, could be used with success for propeller construction. Spruce, on the other hand, was used almost universally, and three of the Allied governments have been looking to America for their supply of this lumber. This has resulted in thoroughly unsatisfactory conditions in the market, as different specifications were being used by the three principal buyers, each buyer being represented at various times by several brokers who were bidding against one another and exacting exorbitant commissions for supplying the products to their clients.

The matter was taken in hand by the board and a man of experience in woodworking operations was secured to represent the board in this connection. A delegation was sent to the Pacific coast, including a member of the lumber committee of the Council of National Defense, and changes were made in cutting specifications at the sawmills, so that a much larger percentage of the log would be available for airplane stock than heretofore and also to the end of making it possible to purchase much less per airplane manufactured than heretofore. This had the further advantage of relieving the transportation situation. In some instances this revision of specifications resulted in reducing the amount of lumber required for one machine from 2,400 to 800 feet, the amount now found adequate for the average type of plane.

The production of spruce in the United States in 1916 was, roughly, 30,000,000 feet, and the board faced a probable demand for 1918 far in excess of this amount. There is practically an unlimited supply of spruce in the forests, but as it runs fairly uniform throughout a given tract in the ratio of not more than fifteen per cent on the entire cut, unless special effort were made to bring out the spruce the supply would be far short.

In manufacturing airplane wings linen has been the fabric used by all factories where obtainable. Its lightness and great tensile strength, the fact that it will not rip when pierced by machine-gun fire or shell fragments, the way in which it absorbs the so-called "dope" applied to its surface, makes it the ideal fabric for this work. There is no production of a fabric of this nature in the United States, the entire supply being obtained from Ireland.

The loss of the Belgian textile towns made it necessary for France to look to Ireland for its linen, and with the enormously enlarged program contemplated it was seen that the supply would undoubtedly be short. After considerable negotiations with the importers in this country representing different mills in England and Ireland an agreement was reached whereby one of their number was authorized to represent the entire group and he was in turn made the official representative of the United States to negotiate all matters pertaining to linen with the British air board there. Arrangements were made for a reasonably adequate supply of linen for the year 1918.

It was soon recognized by the board that steps should be taken at once to fortify our situation in regard to both spruce and linen, if possible, by the development of substitutes. The problem was presented to the Bureau of Standards, which had already conducted numerous experiments along this line.

Other equipment for aviation work, such as motor trucks, machine guns etc., has required the board's attention, as well as many general policies of the Signal Corps, such as the providing of supply depots in this country, construction work here and abroad, aviators' clothing etc.

With the program fairly well established, one of the knotty problems confronting the board was the proper contracting for this material in such a manner that the government would be fairly protected in the expenditure of such large sums of money. It must be remembered that there was practically nothing to be used as a basis in the way of former prices for any of this material, the orders of previous years having been placed in such small quantities that the concerns were unable to accomplish much in the way of lowering costs, and what seemed to be large prices were reported by the manufacturers and borne out in many cases by the yearly profit statements of the manufacturers as being not excessive.

However, new conditions in the form of quantity orders were now to be placed and adequate safeguarding of the government's interests required that every possible effort be made to ascertain proper costs on the articles to be produced. Consideration was essential, however, of the position of the contractor, where in almost every case a large investment was necessary to enable a company to undertake a part of the program. Investment had to be encouraged in an industry which had proved hazardous in years gone by and with the consideration that the termination of the war might see almost a complete stop to future business in anything like the quantities dealt in for the moment.

At the outset of the negotiations with the contractors, the board arranged for its own auditors to go into the plants of the various contractors, and a reliable firm of chartered accountants was retained accurately to ascertain the costs of the various planes and motors. However, many of the articles to be contracted for have never been produced before in this country, and in such cases the board had recourse to independent experts in shop practice and received from them estimates as to what these various articles should cost.

A standard form of cost-plus-fixed-profit contract was in process of development by the board on July 1.

The development of flying fields in this country prior to July 1 received the thoughtful consideration of the board. The original program embraced the construction of twenty-four fields. It was also planned to advise the acceptance of offers from abroad to train there certain numbers of American aviators. A greater development of the flying field program, however, was under consideration on July 1.

The general principle underlying the establishment of aviation training stations was:

1. That such stations should be in the vicinity of centers of material and personnel supply, thus reducing transportation problems.
2. Locations should be sought with favorable topographical and climatic conditions.
3. Consideration should be given to the military use of such fields and their civil use after the war.

In this phase of its work, as in others, the board was brought into close contact with the aviation authorities of the Allied governments, both through its commission abroad and through visits to this country of many of their members.

In the case of Canada a reciprocal arrangement was entered into providing for the training at once of a number of our cadets at Camp Borden, in return for which the United States was to build a double unit school at some point in the South, where Canada may continue her training during the winter months when that work is impossible at Borden.